THE KANSAS UNIVERSITY SCIENCE BULLETIN.

Vol. IV, No. 9—September, 1908.
(Whole Series, Vol. XIV, No. 9.)

CONTENTS:

ICHTHYOLOGICAL NOTES OF THE KANSAS CRETACEOUS, I, *C. E. McClung.*

PUBLISHED BY THE UNIVERSITY,

LAWRENCE, KAN.

Entered at the post-office in Lawrence as second-class matter.

STATE PRINTING OFFICE,
TOPEKA, 1908.
2540

KANSAS UNIVERSITY SCIENCE BULLETIN.

VOL. IV, No. 9. SEPTEMBER, 1908. WHOLE SERIES, VOL. XIV, No 9.

ICHTHYOLOGICAL NOTES OF THE KANSAS CRETACEOUS, I.

BY C. E. McCLUNG.

(Contribution from the Zoölogical Laboratory, No. 176.)

Plates X to XIII, and ten figures.

DURING the course of a restoration of the extinct Cretaceous fish, *Xiphactinus* Leidy, a number of points concerning its anatomy came up for consideration. Several of these called for considerable study, and it was found that they had not been completely worked out before in any specimen. In particular, these concerned the pectoral girdle, the opercular apparatus, and the mandible. It is my purpose in this paper to present, among other things, the facts that appeared from this study.

OPERCULAR BONES OF XIPHACTINUS.

Of this series the operculum, preoperculum, and suboperculum have received extended descriptions at the hands of Stewart, but the exact identity of the suboperculum was not determined, since it is indicated as the "supposed suboperculum." The interoperculum is figured under the caption of "bones of uncertain position." While this entire series has not been observed in position, I feel confident that the relations indicated in figure 1 cannot be far wrong. From the inner side it can be seen that the interoperculum upon this surface has a facet that articulates with a corresponding one on the suboperculum, and when these are in contact and the bones in position the opposite, roughened extremity of the interoperculum just comes into contact with the rugose angular of the mandible. I am therefore of the opinion that the location of the members of this series has been determined with some degree of certainty. Unfortunately the interoperculum is very thin and fragile on

its ventral edge and this is always broken. The complete form cannot therefore be determined from the material now on hand. The most complete specimen in this museum is shown in figure 2. This is the same specimen figured by Stewart ('00, plate 44, figure 5). It is therefore apparent that the opercular apparatus of *Xiphactinus* is of the typical teleost form and presents no peculiarities of importance.

MANDIBLE.

Cope, Crook, Hay and Stewart have described the mandible of *Xiphactinus*, and the main points of its structure have been well presented. The only questions that have arisen concern the articulars and the angular. From the material at my command I am able to state with considerable certainty the form and extent of these elements. An angular is present and is united suturally with the dermaticular principally, but is slightly in contact also with the autarticular and the dentary. Not infrequently, however, it has become separated entirely from its contacts, and in that event its limits are clearly indicated by the strongly roughened sutural surfaces of the remaining bones. In figure 3 is shown a mandible with the angular lacking. It is therefore seen that this element is a small, irregularly triangular structure, and not large, as Cope described it. Hay figured it ('98, p. 36) as a part of the dermarticular, Cope ('75, p. 195) as a portion of the articular (= dermarticular).

With the removal of the angular the nature and extent of the dermarticular is at once apparent, and it may be traced forward into the long process attached to the inner side of the dentary. This portion of the bone is regarded as belonging to the angular by Cope ('75, p. 195) and to the autarticular by Hay ('98, p. 37). There can be no question regarding the identification of this element in the specimen before me. The dermarticular is therefore a large bone, extending fully two-thirds the length of the mandible, and from the ventral edge to the coronoid process. The "sword-shaped process" is merely a thickening of the bone on its ventral edge, and above this it suddenly thins out very much. Into the groove thus formed there rests the autarticular, a short, wedge-shaped bone of irregular outline, whose broad base affords the main articulating surface of the mandible with the quadrate. In front of the autarticular, and resting in the same groove on the inner surface of the dermarticular, is a small, triangular-shaped bone

which Stewart ('00, p. 273) refers to as the "supposed splenial." This is a separate element and can be nothing but the splenial. The two main divisions of the mandible are thus seen to be the dentary and the dermarticular. The latter element forms what might be regarded as the axis of the ramus, with the dentary attached to the outer surface and the autarticular, splenial and angular to the inner. The relative positions of these bones, as seen in a caudal view, are represented in figure 4.

PECTORAL GIRDLE OF XIPHACTINUS.

The pectoral girdle has received considerable attention and, while at first much misunderstood, is now well known in its general features. Some exceptionally good material, however, makes it possible for me to add to our knowledge of this portion of the anatomy and to dispose of a few more unknown or problematical bones. Hay ('98, fig. 9) and Stewart ('99, pl. 45A, figs. 1, 2) have represented major portions of the girdle. In each instance, though, certain elements are omitted, and the relation of the right and left halves is not shown. I think it possible from the specimen before me to present a fairly complete picture of the entire girdle.

In figure 5 is shown a cephalic view of the two girdles in position, with the horizontally directed portion of the clavicle crushed and broken. Very probably this specimen shows the normal relations of the two halves. The hyper- and intercoracoids of the two sides are here seen to be in contact throughout their dorsoventral extent, but an inspection of separated arches indicates that intimate union was restricted to the hypocoracoids. Rising from the dorsal edges of the intercoracoids are the mesocoracoids, which define the space between the two arches. External to the heavy rod-shaped mesocoracoids, and separated from them ventrally by an irregular oval foramen, are the dorsal wings of the clavicles. These are thickened along their cephalic edges where they are in contact with the mesocoracoids, but caudally and beyond this they are thin and delicate. In most specimens this part is broken and gone.

The relations of these parts as viewed from the caudal side may be seen in plate X, drawn from the same specimen after removal from the matrix. The separation of the mesocoracoid and clavicle, except at the cephalic edge, is very evident. Here may also be observed the somewhat complicated sutures be-

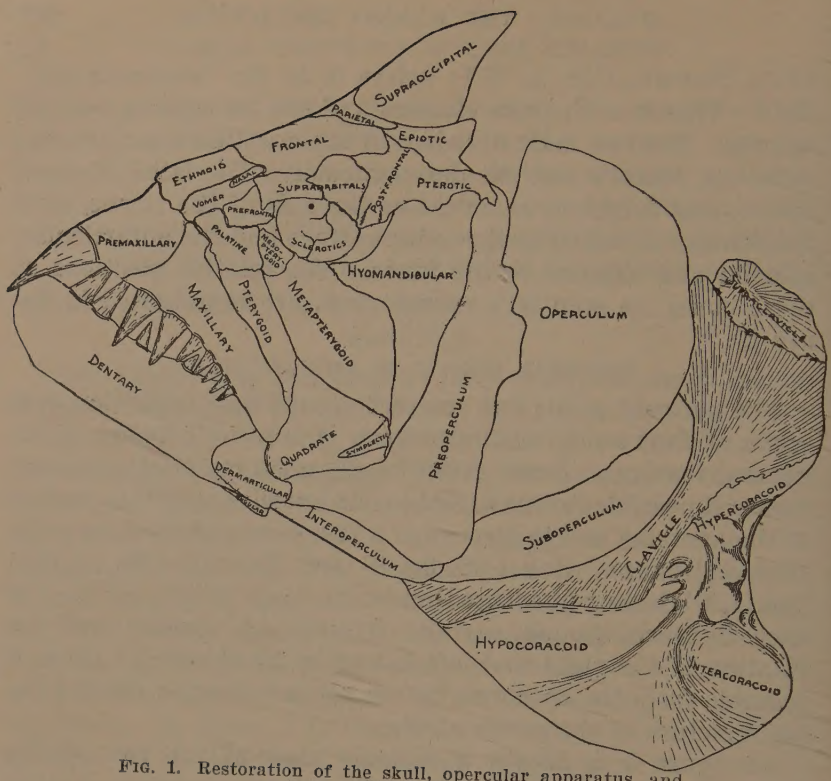

FIG. 1. Restoration of the skull, opercular apparatus, and pectoral girdle of *Xiphactinus*.

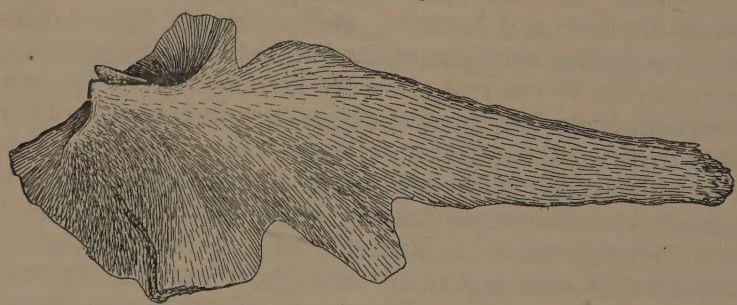

FIG. 2. Interoperculum of *Xiphactinus*, × ½.

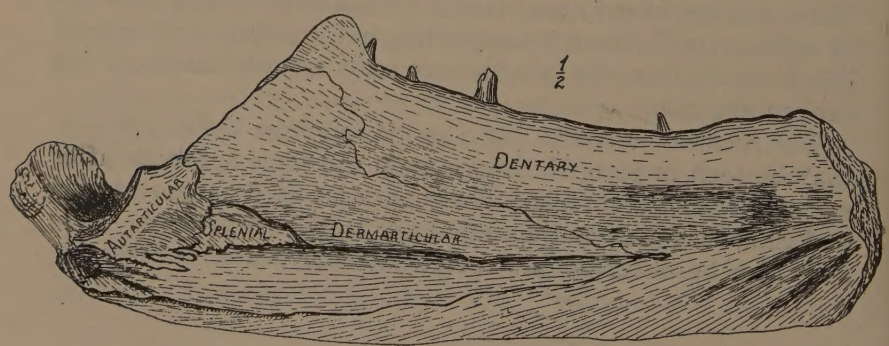

FIG. 3. Internal view of left mandible of *Xiphactinus*, *ca.* × ½.

tween the elements of the girdle. The hypercoracoid is expanded into a broad, thin plate as it disappears under the clavicle. It extends to the ventrocaudal border of the clavicle and dorsally to over half its height. This forms the outer boundary of a long dorsoventral fissure, the entire inner limit of which is fixed by the mesocoracoid. Only above the hypercoracoid plate does the clavicle border this cleft. Hay ('98, p. 43) was in error when he described this fissure as being limited by the outer and inner plates of the clavicle. In the very slightly crushed specimen from which plate X was made the relations of the coracoid elements are beautifully shown. The sutures joining these lie immediately back of the articular facets. Between the hyper- and hypocoracoid is a bone that has not heretofore received notice, and I am unable to homologize it with any described element of the girdle. I shall therefore, because of its position, call it the intercoracoid. It is small and wedge-shaped, with the apex directed dorsally against the base of the mesocoracoid and a mesial wing extending ventrally to unite with the hypocoracoid. Its separation from the hypercoracoid is strongly marked by a heavy suture passing through the fossa where the second baseost is set. A heavy, rounded process arises from the outer dorsal edge of the hypocoracoid and impinges against the ventral, horizontally placed surface of the intercoracoid, just in front of the facet for the articulation of the fin-rays. Some of these relations are better seen in a lateral view, and will be referred to later.

The mesocoracoid rests broadly upon the intercoracoid, and is joined to it by a heavy suture that runs almost horizontally. Above the oval foramen the mesocoracoid sends a broad wing that joins the inner surface of the hypercoracoid at about the level of the outer suture between this bone and the clavicle. The articular facets of the hypercoracoid form an almost straight line, whose angle on inclination is about forty-five degrees from the median plane of the animal. Upon the caudal margin of the hyper- and intercoracoids, at the level of the interspace between the middle and lower facets, are two fossæ for the reception of the T-shaped baseosts. The outer of these lies equally upon the two bones, but the inner and shallower one is entirely confined to the intercoracoid, although its dorsal margin touches the suture uniting this bone to the mesocoracoid.

An external view of the girdle shows all the elements more

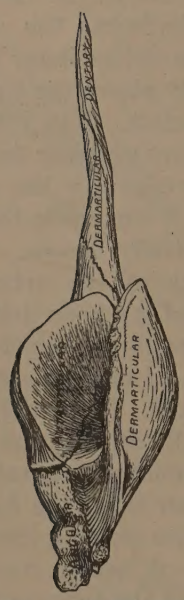

FIG. 4. Caudal view of the right mandible of *Xiphactinus*, × ½.

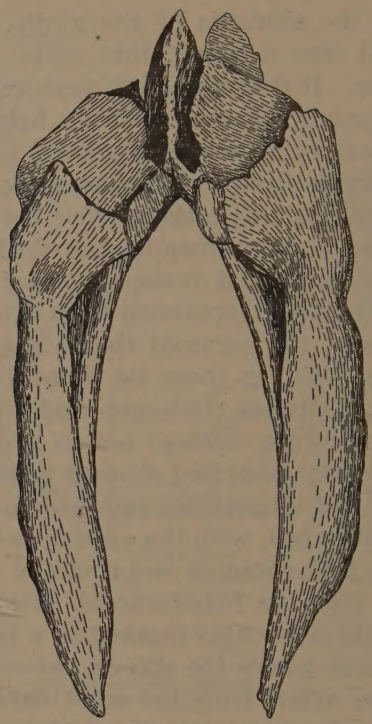

FIG. 5. Cephalic view of the pectoral girdle of *Xiphactinus*, × ¼.

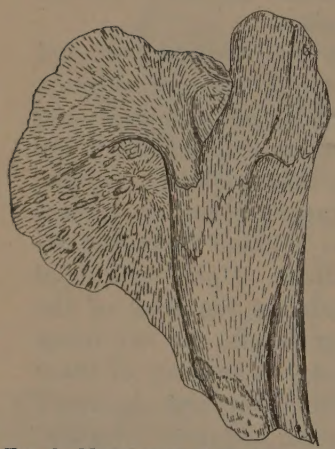

FIG. 6. Mesial view of the left supraclavicle of *Xiphactinus* attached to the clavicle, which is interposed between it and the mesocoracoid, × ⅛.

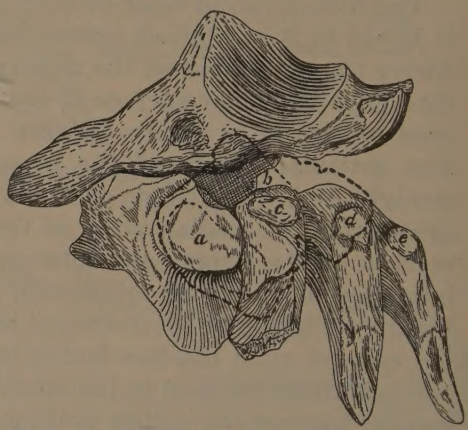

FIG. 7. Proximal ends of fin-rays of *Xiphactinus*, showing their articulations with the girdle and baseosts, × ½.

or less completely. The largest of these is the clavicle, which only slightly exceeds in size the hypocoracoid. Between these elements is placed the heavy hyper- and intercoracoids, the former bearing the facets for articulation with the fin-rays. The dorsal portion of the hypercoracoid is joined by a heavy suture to the ventral border of the vertical limb of the clavicle. Beyond this point, as was noticed in the description of the caudal view, a thin plate extends dorsally between the clavicle and mesocoracoid. The inner ventral margin, at the level of the lower and middle facets, is joined to the inter- and mesocoracoids.

Except for a heavy process arising from the outer surface to join the ventral edge of the intercoracoid, the hypocoracoid is a thin, fragile bone which is nearly always broken at the edges. From a number of specimens the various parts of this edge have been observed and from them the restoration in plate XI made. Just in front of the suture joining this bone to the hypercoracoids is an oval foramen piercing the hypocoracoid. This was described as absent by Hay ('98, p. 43). Sometimes there are several of these. Ventral to this are two stout processes running forward, approximately parallel. These join the stout dorsocaudal process of the hypocoracoid to its thin inner plate. Elsewhere these are separate. Aside from these diversities the bone is uniformly thin, except at the dorsal edge, where it thickens strongly to join the hyper- and mesocoracoids.

The clavicle has been well figured and described except that usually it has been represented as too narrow dorsally. But so far as I have been able to discover there has been no record of the supraclavicle that attaches to the dorsal edge of the clavicle. This is the "uncertain bone" shown by Stewart (figure 2, plate 44). A portion of it is attached to the girdle from which Stewart's figure 1, plate 45A, was made, but it does not appear in the drawing. In a number of specimens it can be seen, on the inner side, attaching firmly to the caudal margin of the dorsally projecting process of the clavicle, and, by means of a thickened ridge, to the angle which this clavicular process makes in descending to join the dorsal edge of the mesocoracoid. Upon the inner surface of the thin, caudal portion of the clavicle it becomes much attenuated and gradually thins out. It does not anywhere come into relation with the mesocoracoid. (See figures 1 and 6.)

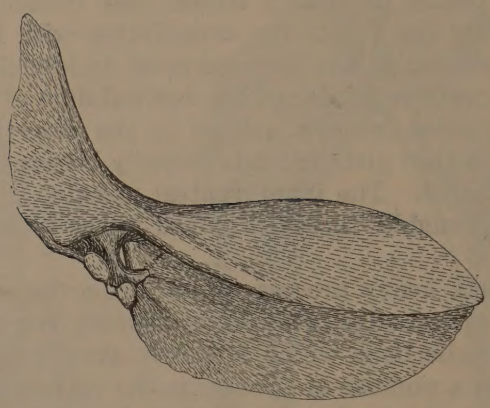

FIG. 8. External view of the right side of the pectoral girdle of *Gillicus*, × ½.

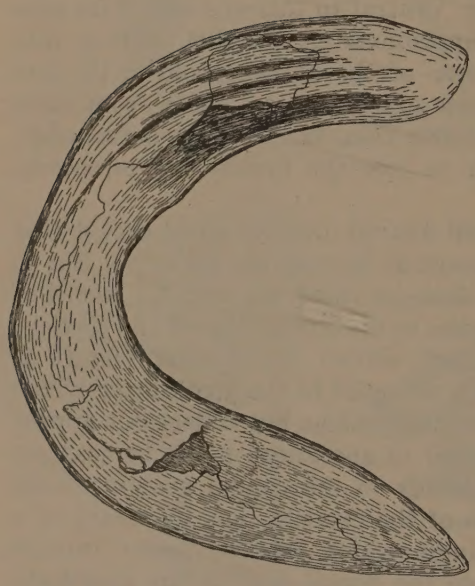

FIG. 9. External view of right half of the pectoral girdle of *Protosphyræna*, × ⅓.

FIG. 10. Caudal view of left half of pectoral girdle of *Protosphyræna*, × ½.

The articulation of the fin-rays with the girdle has been correctly described, in its general features, by Stewart ('00, p. 284), but a few details may be added. In figure 7 are shown the proximal ends of the fin-rays, and upon them, in dotted outline, the largest baseost. The fainter dotted outlines within represent the articular facets which are applied to the lower two of the hypercoracoid. The deep depression in the proximal end of the first dorsal fin-ray abuts against the upper facet of the hypercoracoid. Upon the opposite side of the large baseost are a number of articular surfaces for contact with the ventral fin-rays. Just under the proximal ventral facet (*a* of figure 7) is a large flattened surface which articulates with a similar area upon the proximal end of the first ventral fin-ray. At the opposite extremity is an elongate, irregular facet which affords contact with the second, third, and possibly fourth, ventral rays through their facets *c*, *d* and *e*. The exact position in the fin apparatus of the two T-shaped baseosts is not exactly determinable, but their proximal ends are set in the two deep depressions of the hypercoracoid and intercoracoid. The distal ends, with their broad articular surfaces, undoubtedly bore upon the proximal ends of the fin-rays.

The relative positions of the various bones may be seen from an inspection of plate XII, which is from a photograph of the restoration in the University of Kansas.

PECTORAL GIRDLE OF GILLICUS.

Several fine specimens in the museum of the University of Kansas make it possible to give a fairly complete picture of the pectoral girdle of *Gillicus*. One is at once struck with the general resemblance this bears to the corresponding structure in *Xiphactinus*. Such differences as there are may be referred very largely to variations in proportions. An examination of figure 8 will give a general idea of the lateral aspect of the girdle. Here it will be seen that the ventral limb of the clavicle is much larger in proportion than it is in *Xiphactinus*. The dorsal limb is of the same general form, but no supraclavicle was found. In all probability it was present, however, for an articular surface similar to that of *Xiphactinus* is evident. The hypocoracoid also is larger in proportion and is widely separated from the large ventral limb of the clavicle, except at the dorsal edge, where they are in contact.

The hypercoracoid is a miniature replica of the corresponding bone in *Xiphactinus*. The facets for the articulation of the

fin-rays and baseosts are similar in form and position. The two cup-shaped depressions for the reception of the T-shaped baseosts are present and the first is bisected by the suture separating the hypercoracoid from the intercoracoid. The mesocoracoid, like all the other bones of the girdle, is not so robust as the corresponding element of *Xiphactinus,* but in form and position is similar to that of the larger fish. Indeed, the very evident and minute resemblances between the pectoral fin apparatus of *Gillicus* and *Xiphactinus* clearly point to the close relationship between the genera and justifies their inclusion in a common group.

GIRDLE OF PROTOSPHYRÆNA.

The girdle of this genus has been described at considerable length by Cope and Hay, and the specimens at my command enable me to add only some small details to what has already been published. In figure 9 is shown an external view of the clavicle, from which it is evident that only a part of the bone has previously been figured. Hay shows in his figure 7, page 13, the most complete specimen that I have seen mentioned. Cope represents only fragments attached to the heavier bones. On the dorsal limb the cephalic edge is much thickened (figure 10), strengthening the girdle after the manner of the mesocoracoid in *Xiphactinus.* The specimen from which figure 9 was made is not well preserved, having been taken from the shaly lower stratum of the chalk, but the outline of the entire bone was preserved in the matrix and is shown in the restoration.

The relations of the complex of girdle bones is shown in figure 10, drawn from a specimen that has suffered very little distortion. Unfortunately, the sutures are almost entirely obliterated by the close union of the various bones, so that little can be added to what is already known regarding the limits of the individual elements. Owing to the undistorted condition of the specimen, however, the exact form and position of the various parts are clearly shown. Thus the mesocoracoid is observed to occupy somewhat the same position that it does in *Xiphactinus,* leaving an oval foramen between itself and the upward extension of the hypercoracoid. Instead of being suturally connected with the clavicle it rests in a depression formed by the straight, ventral extension—past the curved cephalic edge—of the thickened process of the clavicle. The hypercoracoid is not suturally separated from the hypercora-

coid but is a heavy bone bearing three facets for the articulation of the fin-rays. Very probably also it contains one or more of the six oval pits for the reception of the baseosts, since the mesocoracoid rises above the first, second and third of these. The fin-ray articulations are quite unlike those of *Xiphactinus* and *Gillicus*, being much roughened for the attachment of ligaments. The entire construction of the girdle would indicate little movement of the fin, which was apparently more or less rigidly braced against the body. The hypocoracoid is a heavy, irregular bone, large dorsally, where it bears some of the pits for the baseosts, and thinner ventrally. It is flattened in a cephalocaudal direction at right angles to the plane of compression in the clavicle. In the specimen from which figure 10 was drawn the ventral portion shows a roughened edge, probably indicating the presence of another element.

It is evident from the construction of the girdle that the differences are considerable between *Protosphyræna* and the other genera considered here, and lend further justification to the classification which places it in a group by itself.

CAUDAL FIN OF PROTOSPHYRÆNA.

The entire skeleton of any member of this genus has not yet been discovered. There is therefore lacking a knowledge of several portions of the body, among which are the occipital region of the skull, the vertebral column and the caudal fin. Light upon all these points is afforded by material now at my disposal. I wish here to consider the caudal fin and incidentally the vertebræ. Through purchase from Mr. C. H. Sternberg the University of Kansas has come into possession of a specimen of the caudal fin, which not only shows the nature of this organ but also clearly demonstrates the absence of ossified vertebræ. In plate XIII is represented a lateral view of this specimen, from which the essential features may be understood without much description. The ossified neurals and hæmals appear very plainly, as they do in the nearly related *Hyposocormus*, according to Woodward, but the centra are absent. The last hæmal is considerably modified, forming a urostyle, to which many of the fin-rays attach. This bone is frequently found by collectors, but its character and relationships have not heretofore been understood. The fin-rays are fine, closely apposed and very numerous. In the specimen under consideration they are incomplete and broken, so that the exact form of

the fin cannot be ascertained. Apparently it was broad and firm.

Owing to the isolated condition of the specimen its specific position cannot be determined, and any attempt to do this would be only a guess. It is an important specimen, however, since it definitely places the genus in the family *Pachycormidæ*, upon the assumption that only the uncertainty of vertebral characters previously made the classification doubtful.

BIBLIOGRAPHY.

COPE, E. D., 1875. Report of the U. S. Geological Survey of the Territories, vol. II. The Vertebrata of the Cretaceous Formations of the West.

CROOK, A. R., 1892. Ueber einige fossile Knochenfische aus der mittleren Kreide von Kansas. Stuttgart.

HAY, O. P., 1898. Observations on the Genus of Fossil Fishes called by Professor Cope Portheus, by Doctor Leidy Xiphactinus. Zoölogical Bulletin, vol. II, No. 1.

STEWART, ALBAN, 1900. Teleosts of the Upper Cretaceous. The University Geological Survey of Kansas, vol. VI.

THE KANSAS UNIVERSITY SCIENCE BULLETIN.

Vol. IV, No. 10—September, 1908.
(Whole Series, Vol. XIV, No. 10.)

CONTENTS:

RESTORATION OF THE SKELETON OF BISON OCCIDENTALIS, *C. E. McClung.*

PUBLISHED BY THE UNIVERSITY,

LAWRENCE, KAN.

Entered at the post-office in Lawrence as second-class matter.

STATE PRINTING OFFICE,
TOPEKA, 1908.
2540